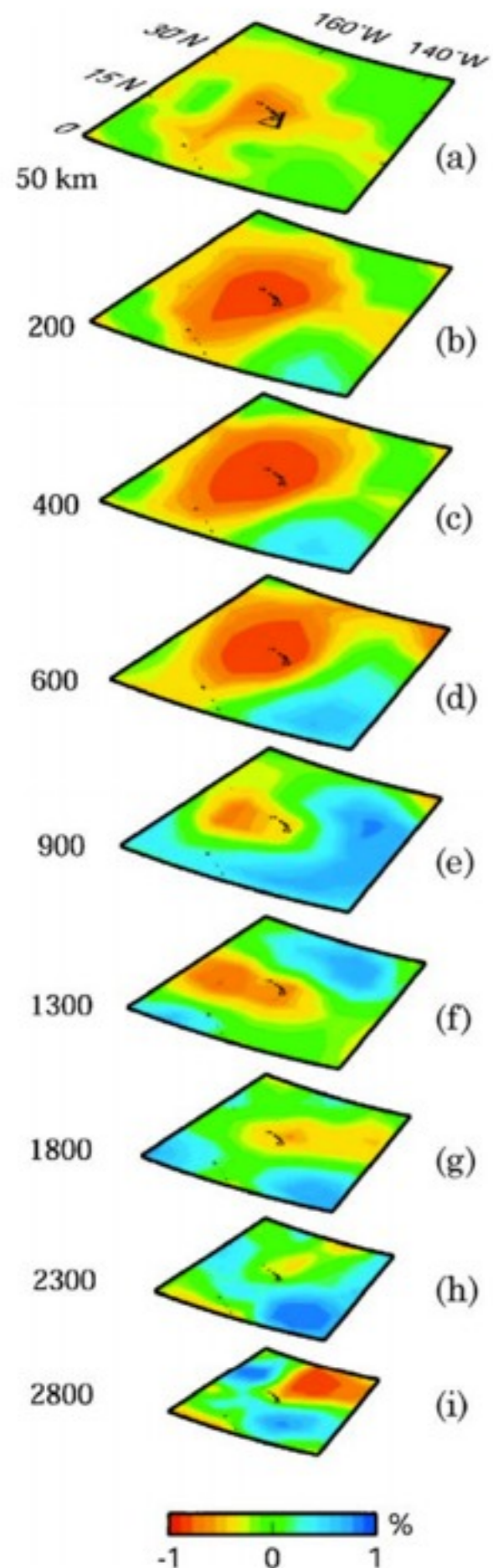


eRHIC as a Nucleon Tomograph

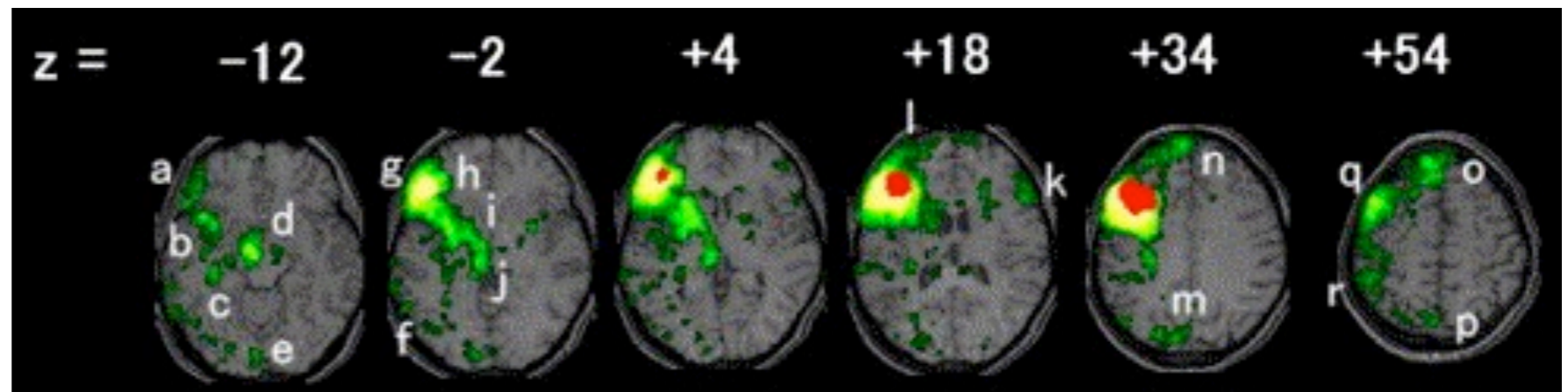
Thomas Burton
DNP Fall Meeting
Newport Beach CA
Saturday 27th October 2012

Tomography

J. Lei, D. Zhao, Earth and Planetary Science Letters **241**, 438–453 (2006).



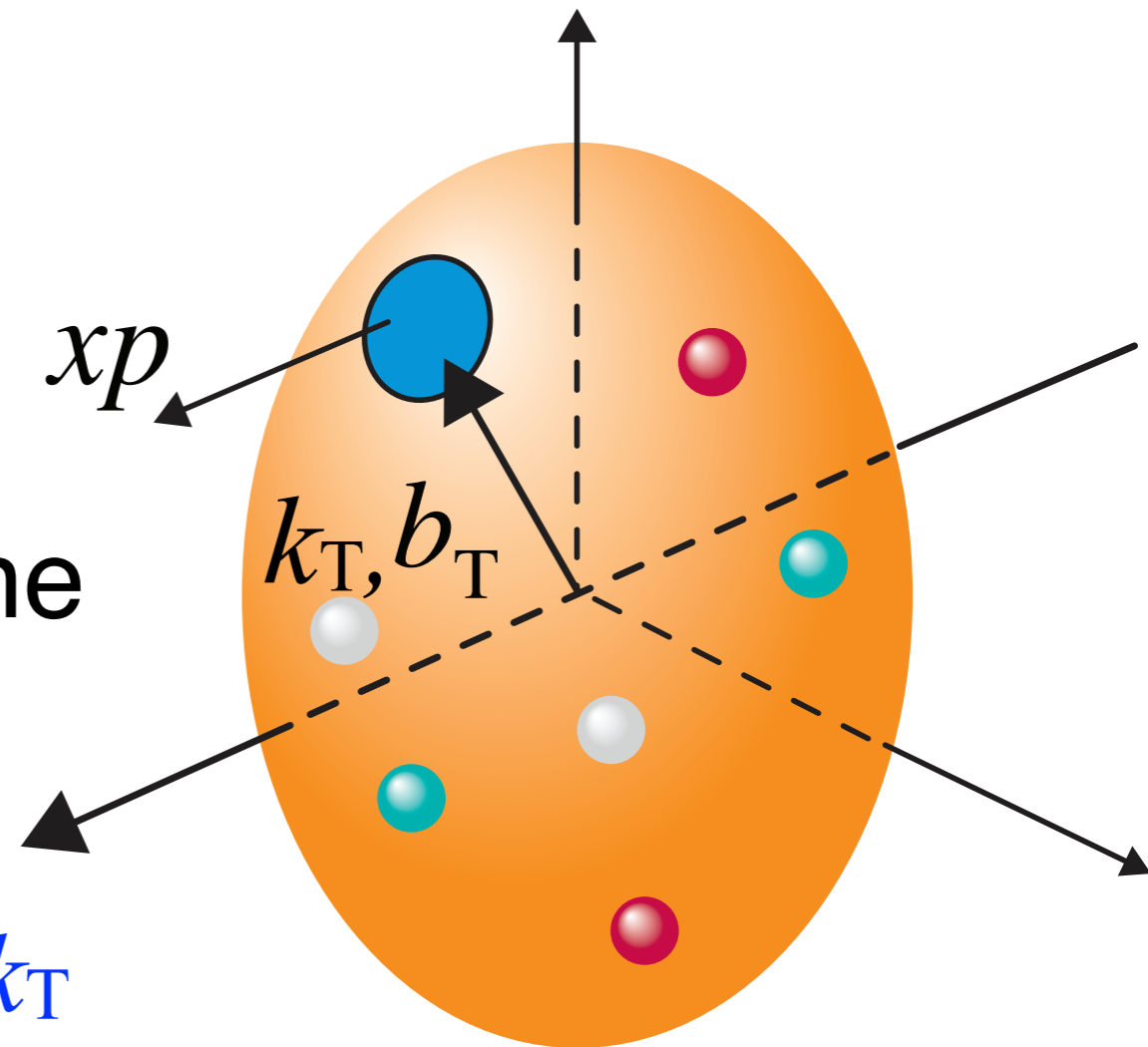
E. Takahashi, K. Ohki, D-S. Kim, NeuroImage **34**, 827-838 (2007).



- **Imaging in 2D slices**
- Tomographic techniques in many fields: medicine, oceanography, seismology...
- Want to do the same for **nucleons**
 - ▶ How to “image” on scales of 10^{-15} fm?

Nucleon Tomography

- 2D image in transverse plane
- Two **types**, two **tools**:
 1. Transverse **momentum**, k_T
Semi-inclusive measurements
 2. Transverse **position**, b_T
Exclusive measurements



1) Transverse momentum

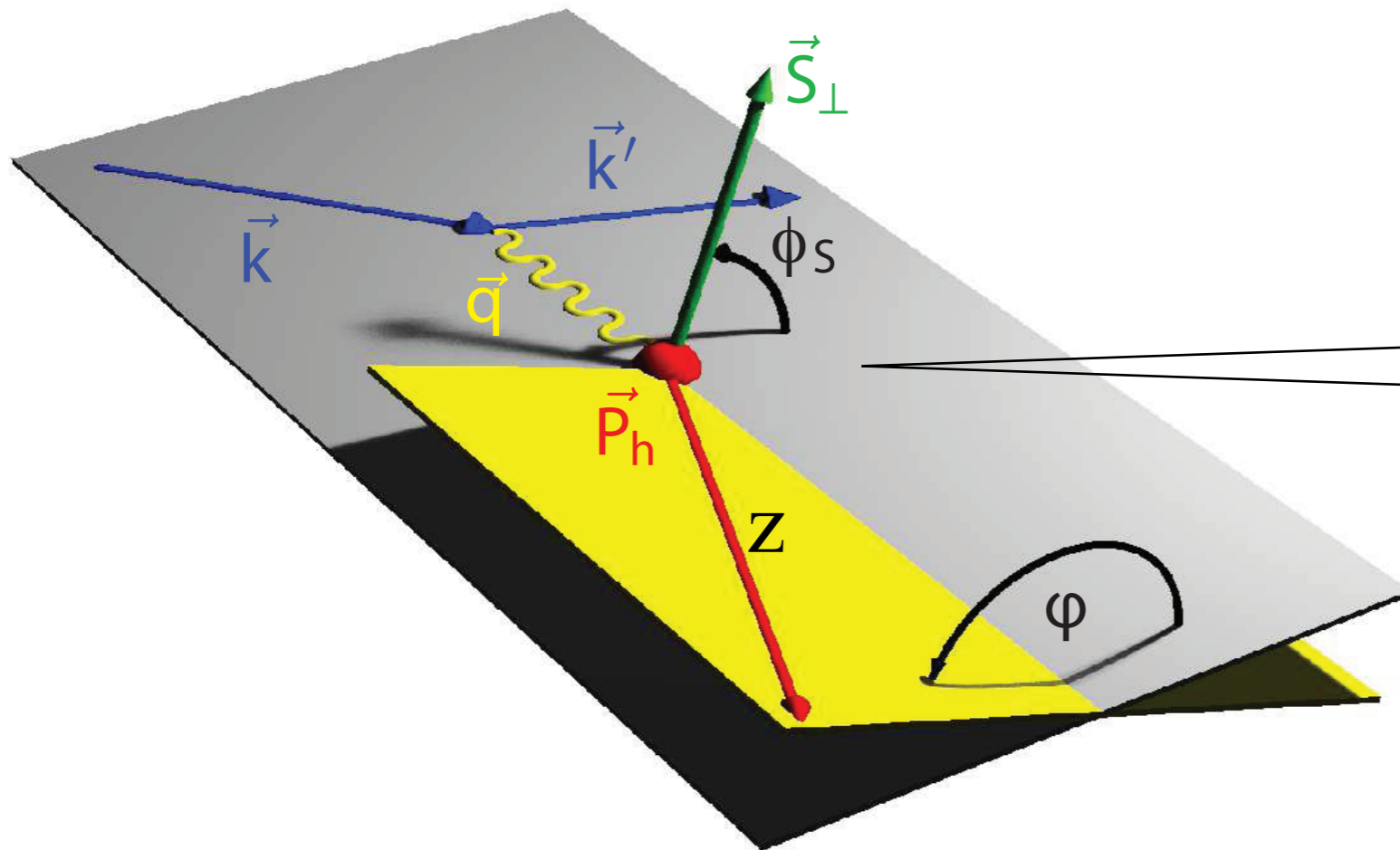
SIDIS

Semi-Inclusive Deeply Inelastic Scattering

Measure the
electron + a
single hadron



characterised via
(z, p_T)



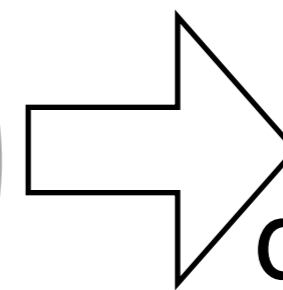
DIS
 x, Q^2

+

semi-
inclusive
 z, p_T

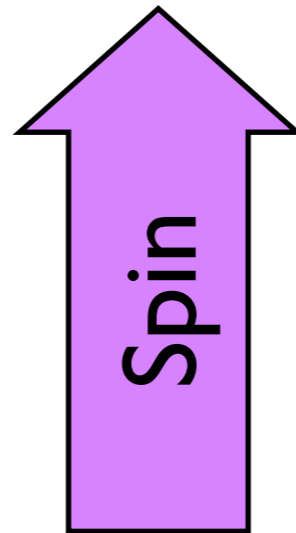
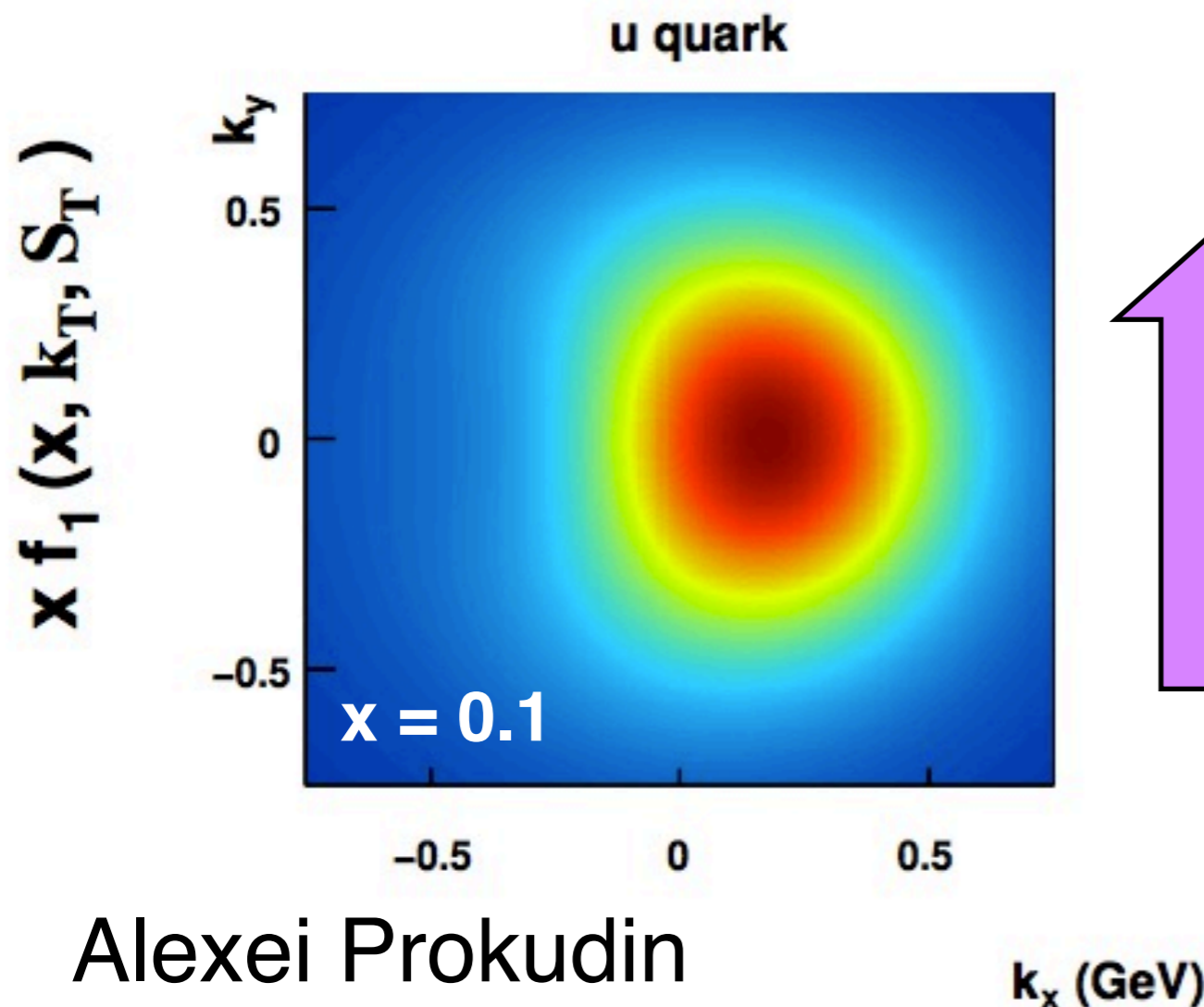
+

spin
 ϕ



Multi-
dimensional

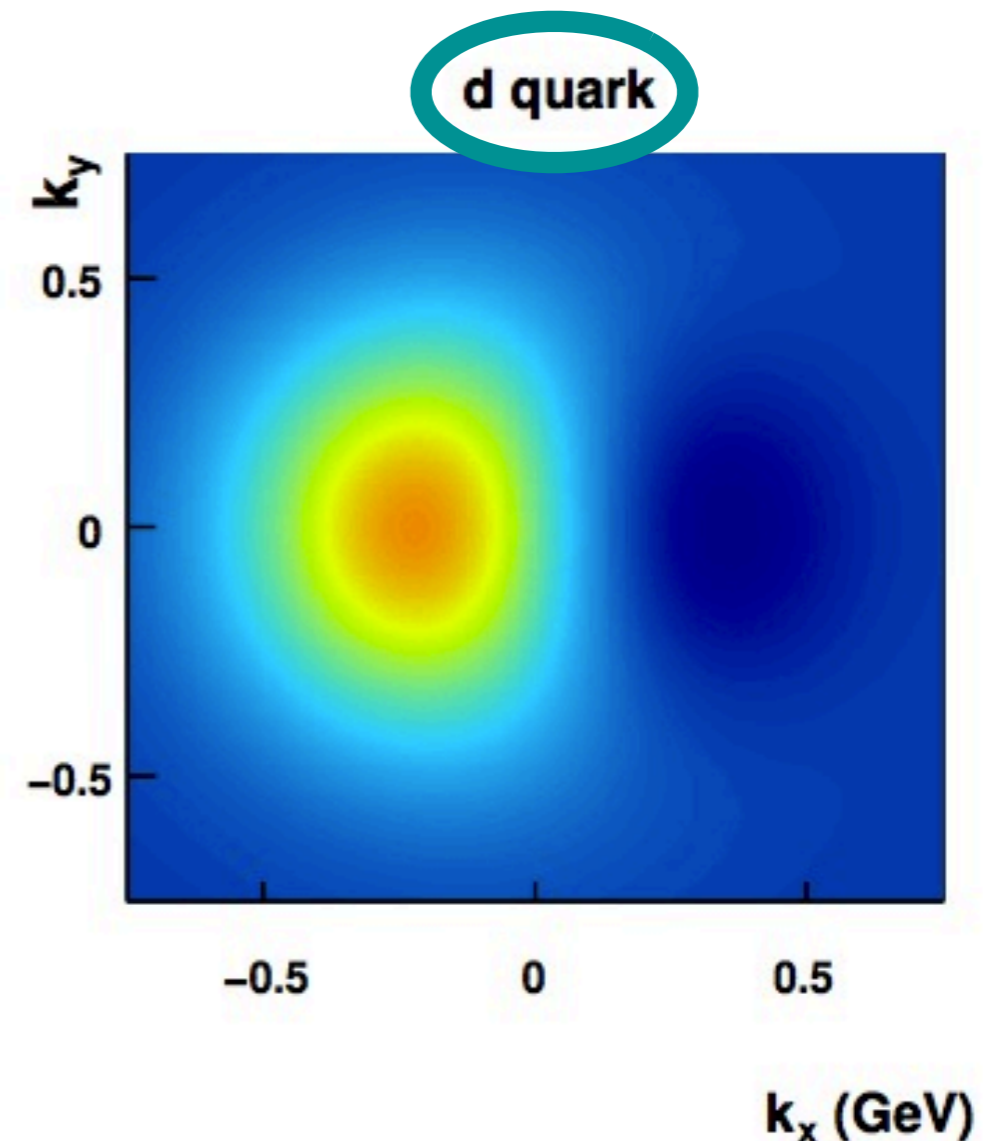
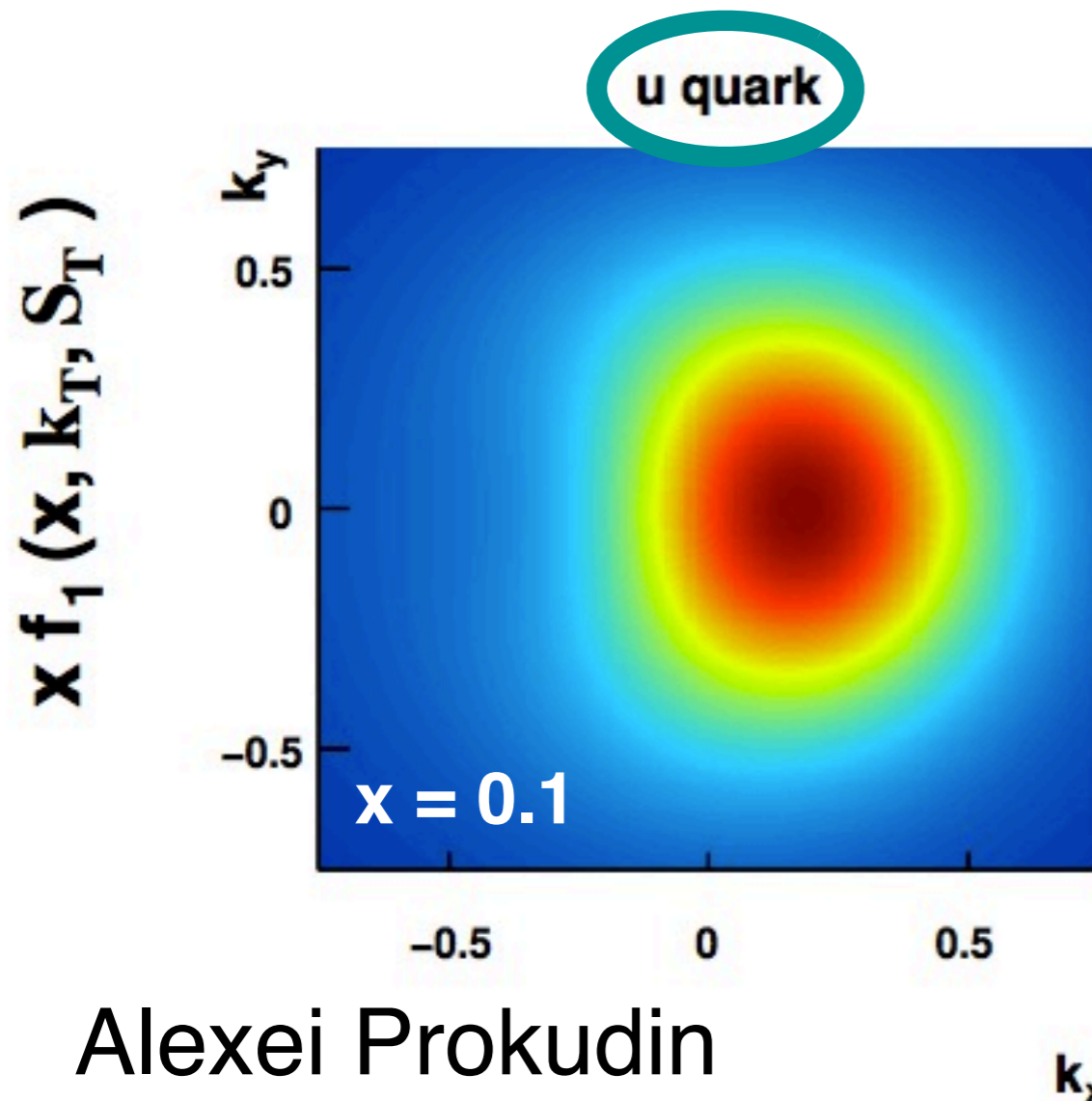
- Gives additional hadron information
 - extract “*transverse-momentum-dependent distributions*”: **TMDs**



1) Spin-dependence:
see deformation of
parton distribution
e.g. **Sivers** function

Alexei Prokudin

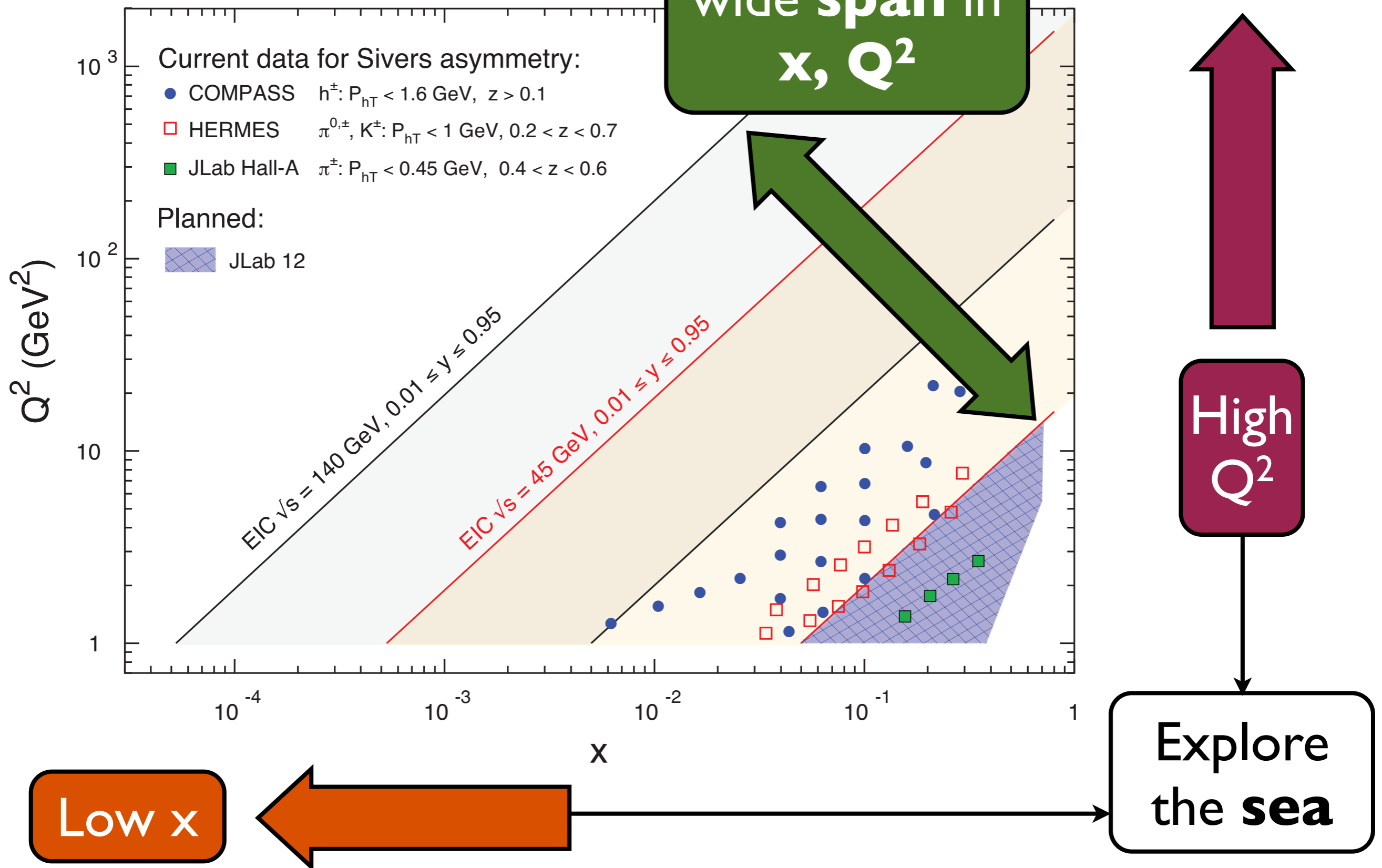
- Gives additional hadron information
 - ▶ extract “*transverse-momentum-dependent distributions*”: **TMDs**



Alexei Prokudin

2) Identify hadrons: decompose **flavour** dependence

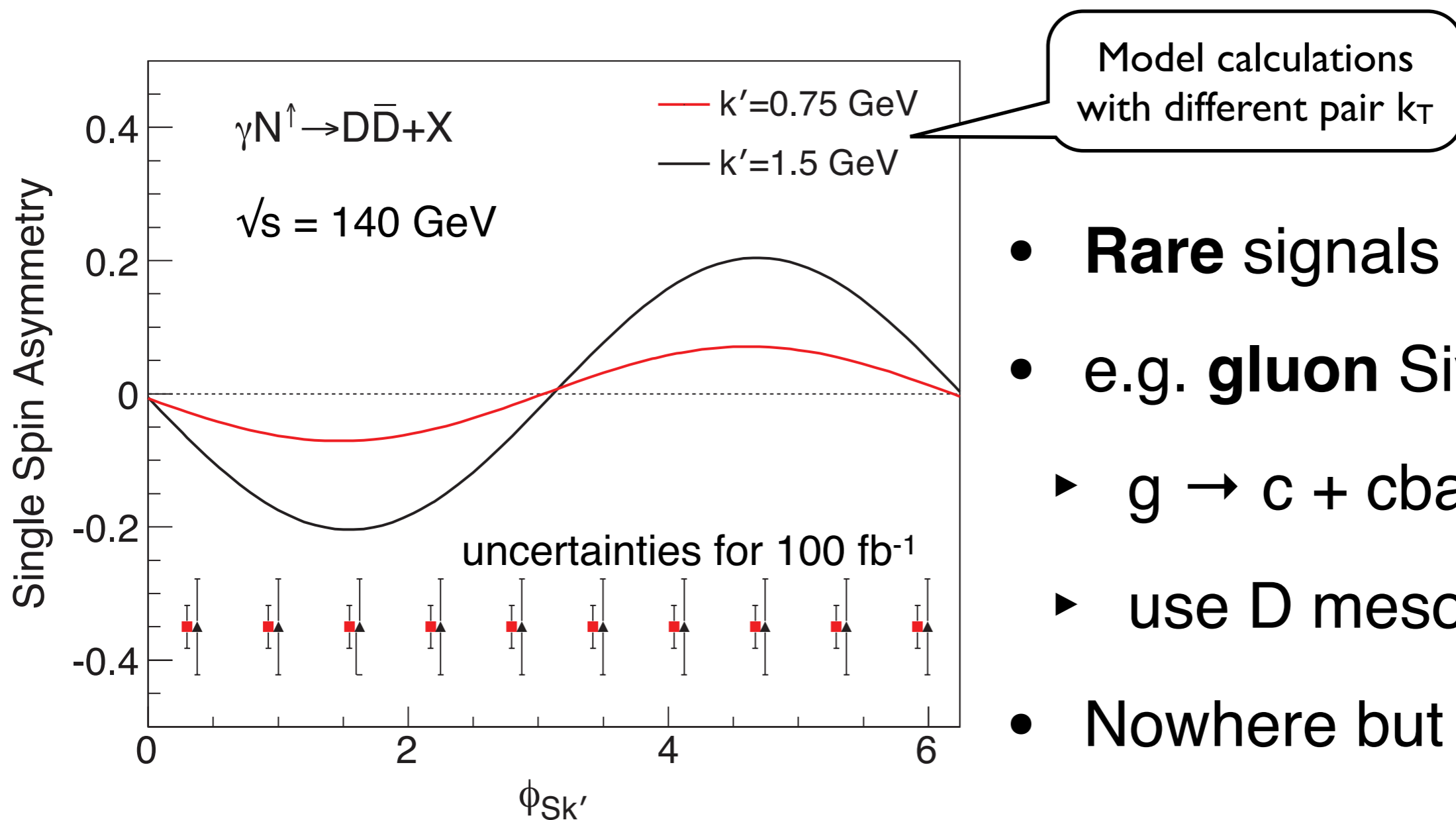
Kinematics



Luminosity

$10^{34} \text{ cm}^{-2}\text{s}^{-1}$: 100s times HERA

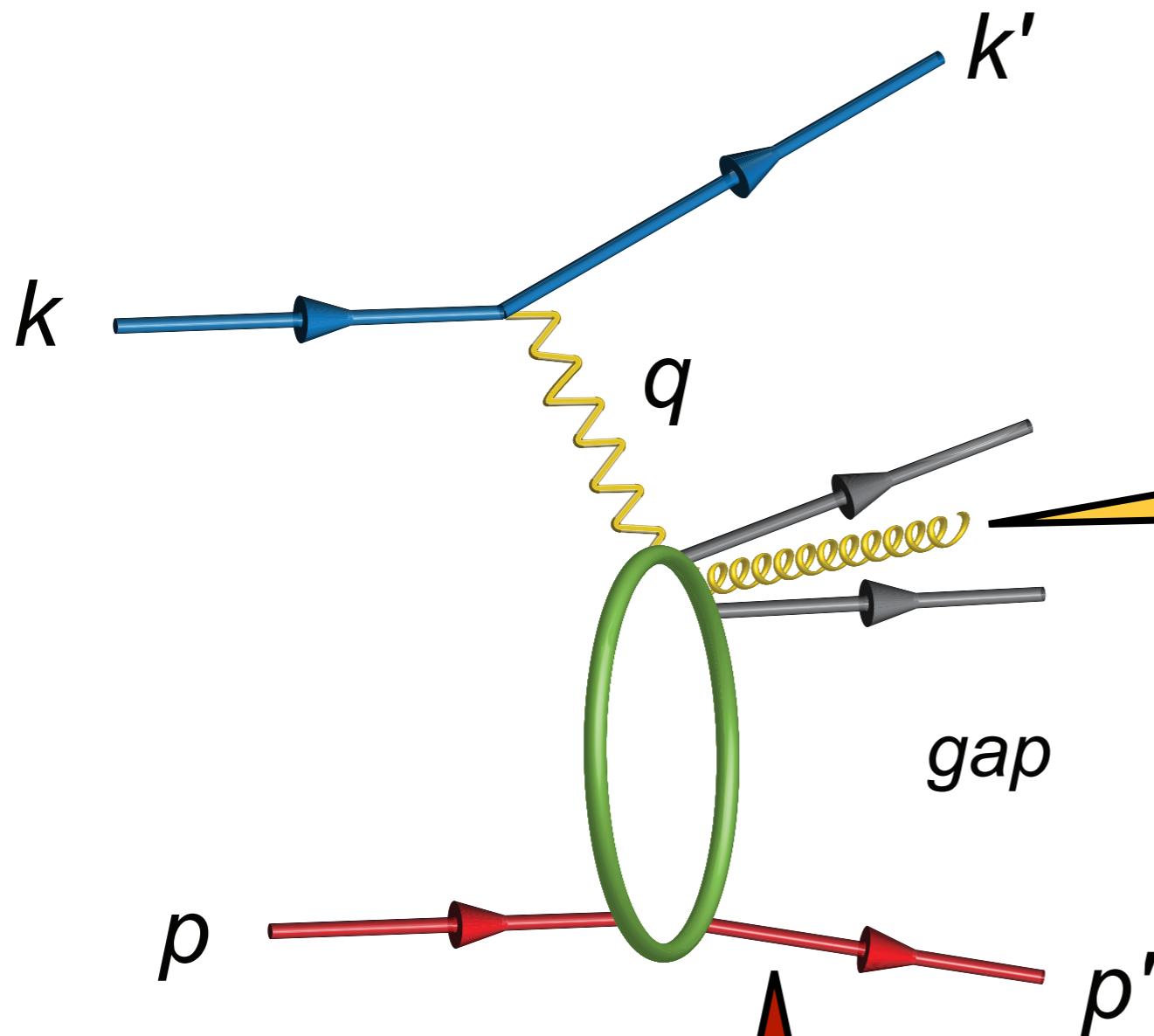
- Measurements with π , K very precise
 - mostly **systematics**-dominated



- **Rare** signals accessible
- e.g. **gluon** Sivers
 - $g \rightarrow c + \bar{c}$
 - use D meson pairs
- Nowhere but an EIC

2) Transverse position

Exclusive production



Exclusive reaction:
produces a **single**
boson: γ , J/ψ , ϕ ...

4-momentum
transfer to
proton: t

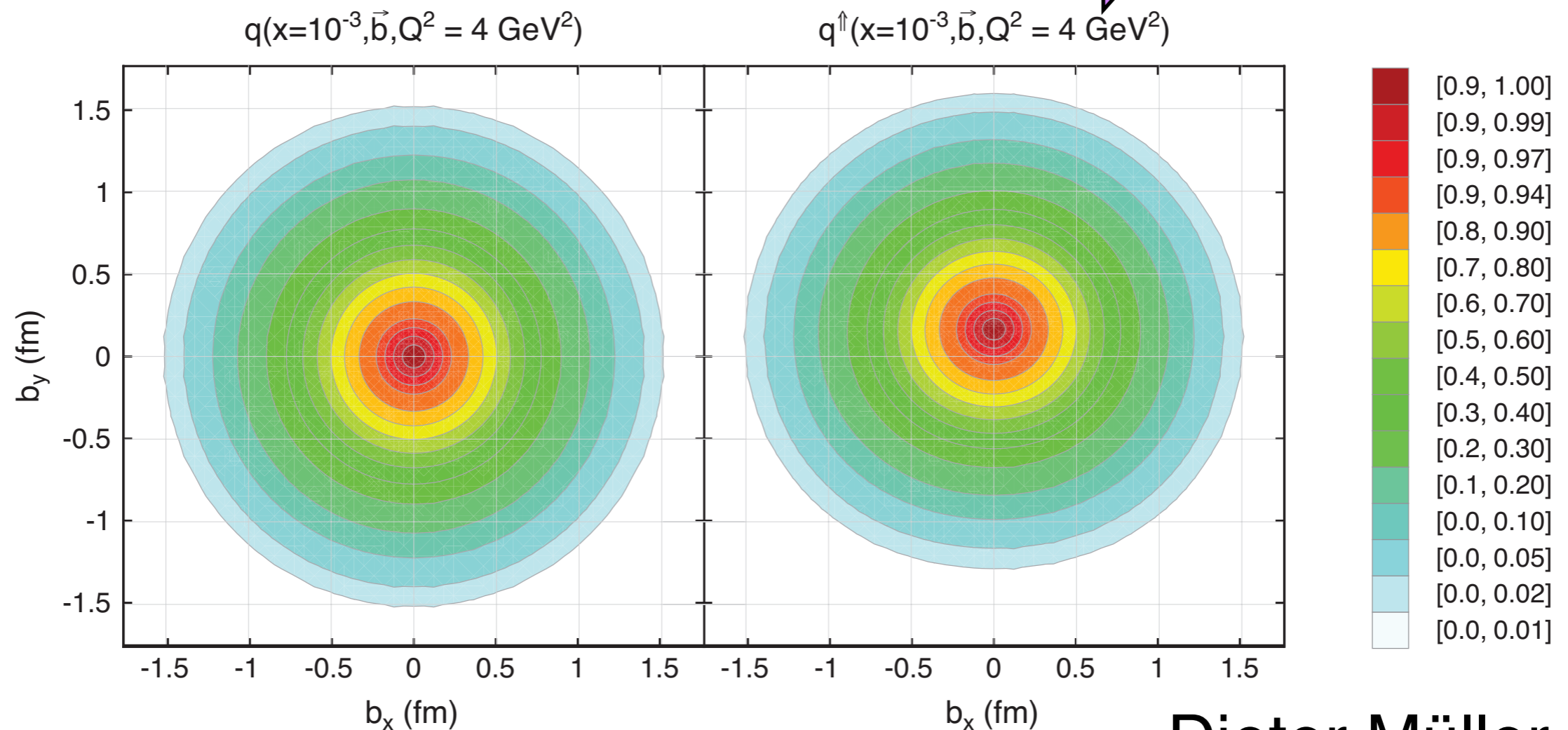
Provides access to
“*generalised parton
distributions*”, GPDs

b dependence

- **Fourier transform of $d\sigma/dt$:**

- ▶ **b** dependence
- ▶ **2D spatial picture**

Spin → Investigate effect of spin



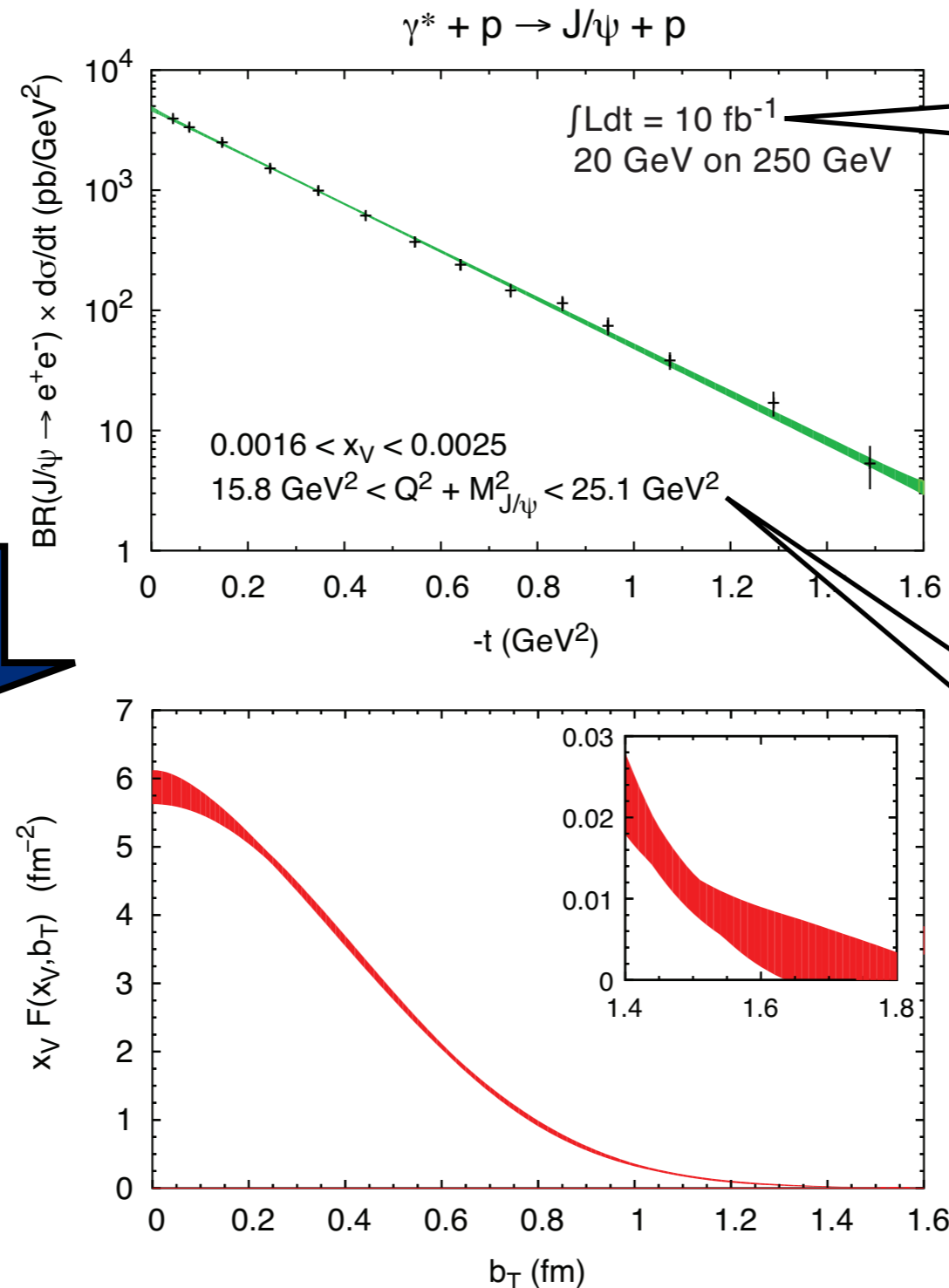
Dieter Müller

J/psi production

t

**Fourier
transform**

b

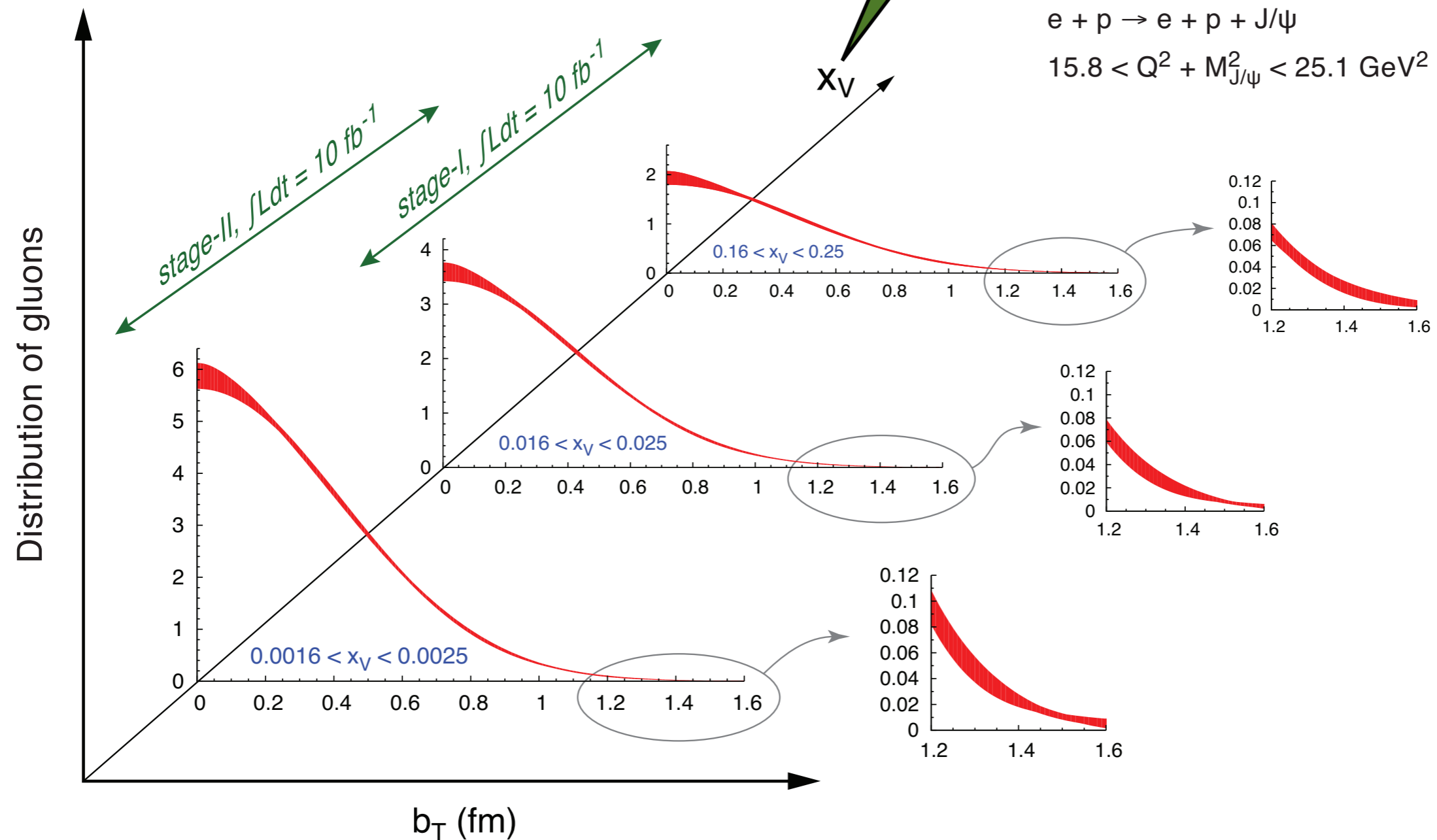


**Tiny statistical
errors in < 1
year running**

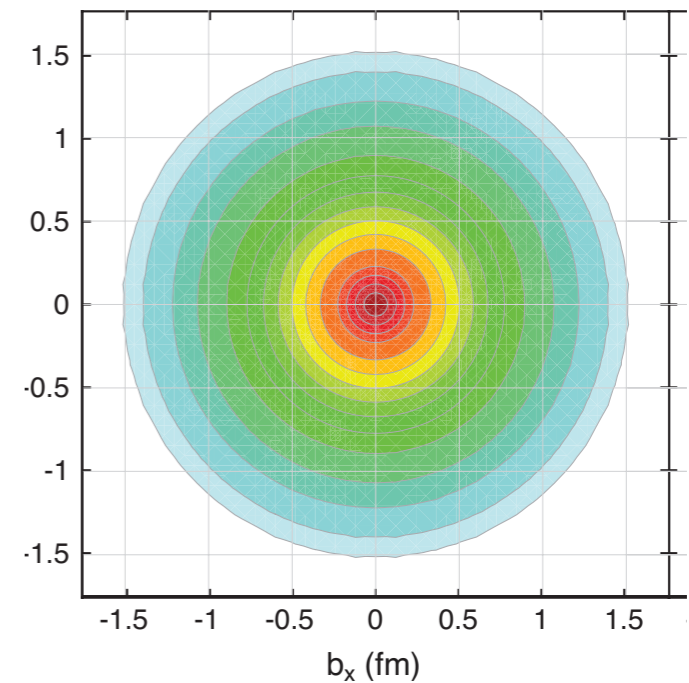
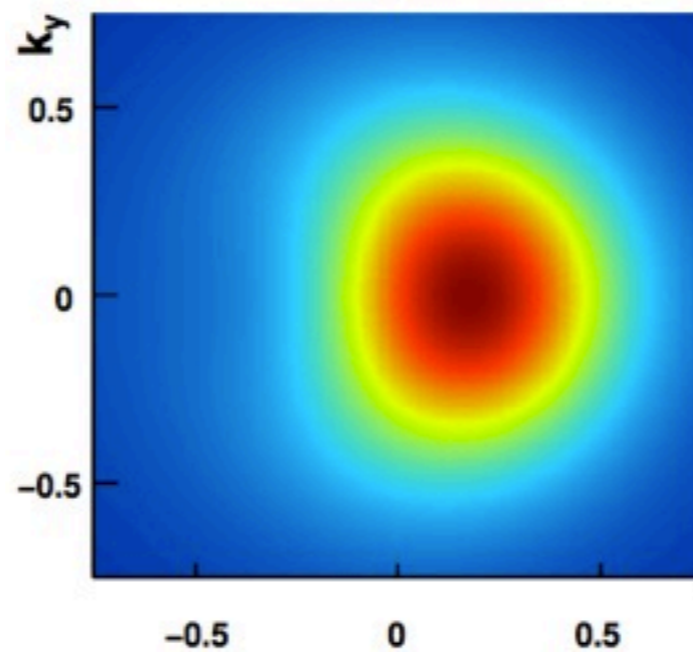
**Fine binning in
(x, Q^2, t)**

J/psi production

b-dependence “slices”
through x space

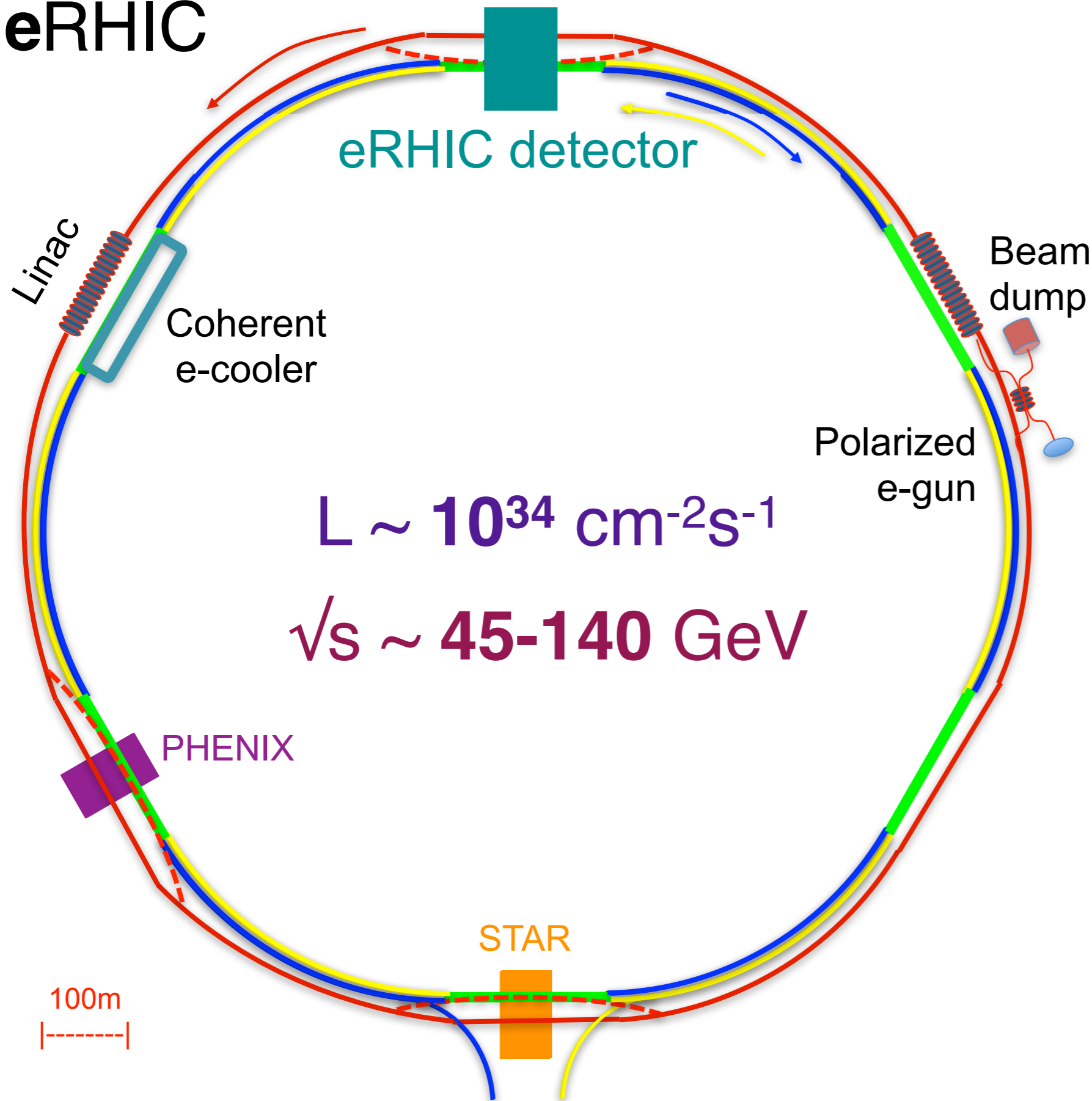


Overview



- **Nucleon imaging: a major EIC goal**
 - tomographic view matter on scales $\sim 10^{-15}\text{m}$
- eRHIC provides the necessary
 - **luminosity**
 - **energy variability**
- Proposed to begin operations ~ 2022 .

eRHIC



What is eRHIC?

RHIC +
high **intensity**,
high **energy**
electron beam

p and **e**
polarised

Hadron beams
A=1 to A=238